PDGdb.jl

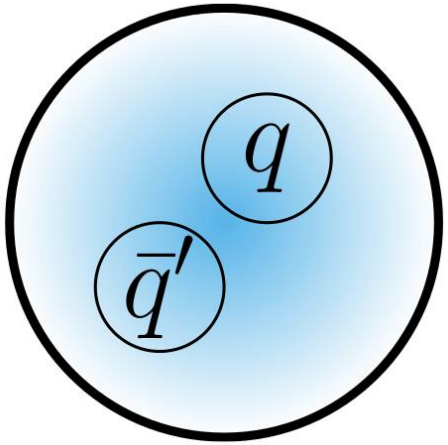
Wrangling the Particle Data Base

Mikhail Mikhasenko

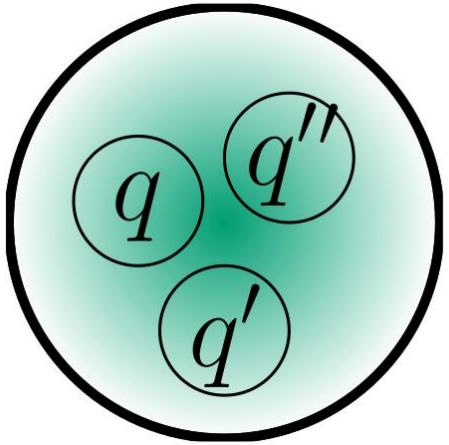
Ruhr University Bochum

Erlangen, 7/11/2023

2. Hadrons. Why so many?

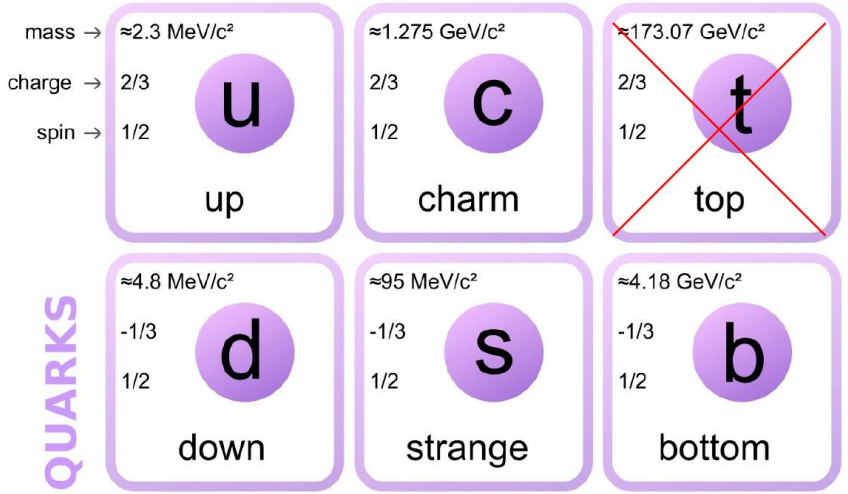


meson



baryon

$\otimes$



$\sim$ 10 classes of mesons

$(\pi, \eta, K, D, D_s, B, B_s, B_c, \phi, \psi, \Upsilon)$

and

$\sim$ 20 classes of baryons

$(N, \Delta, \Lambda_{(b/c)}, \Xi_{(b/c)}, \Omega_{(b/c)}, \dots)$

$\otimes$ excitement**

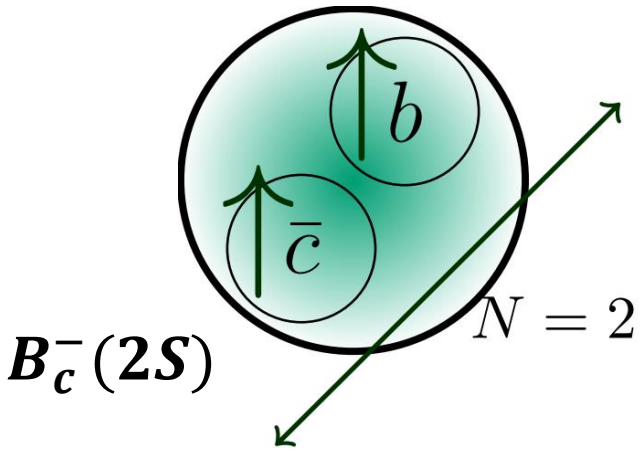
Excitation pattern

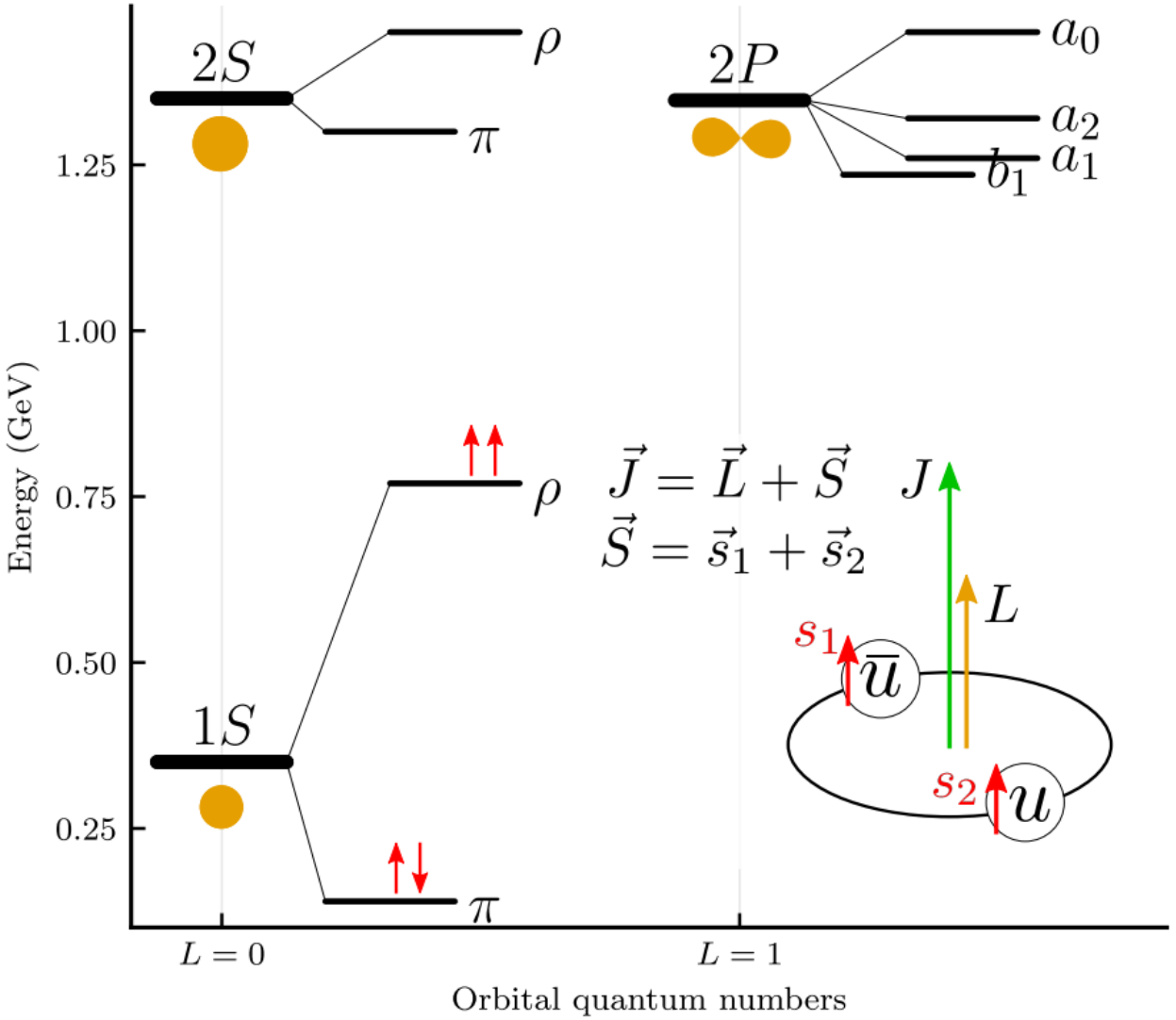
Example: light meson spectrum

Mesons in Quark model:

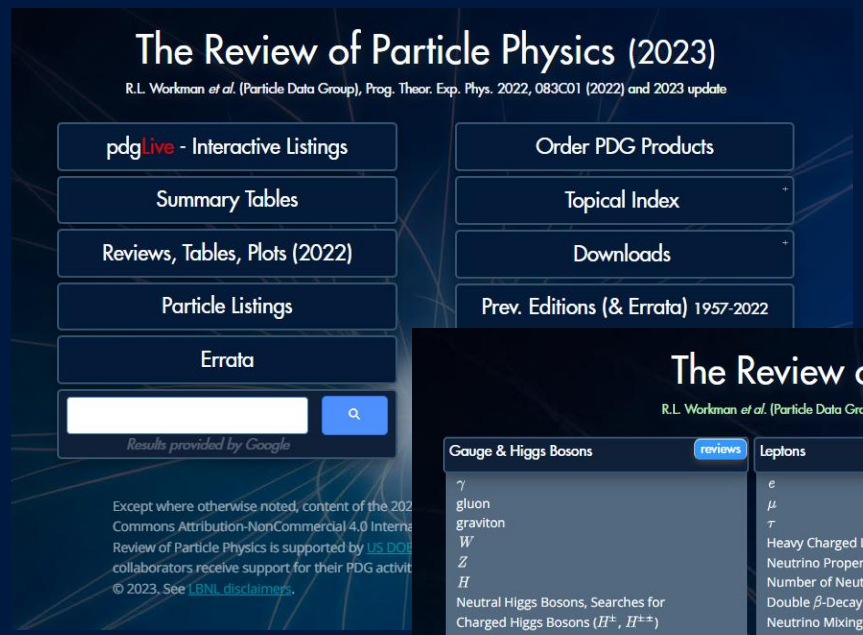
- **Orbital angular momentum**
- **Spin of constituents**

- **Radial excitation**





PDG live


The Review of Particle Physics (2023)
R.L. Workman et al. (Particle Data Group), Prog. Theor. Exp. Phys. 2022, 083C01 (2022) and 2023 update
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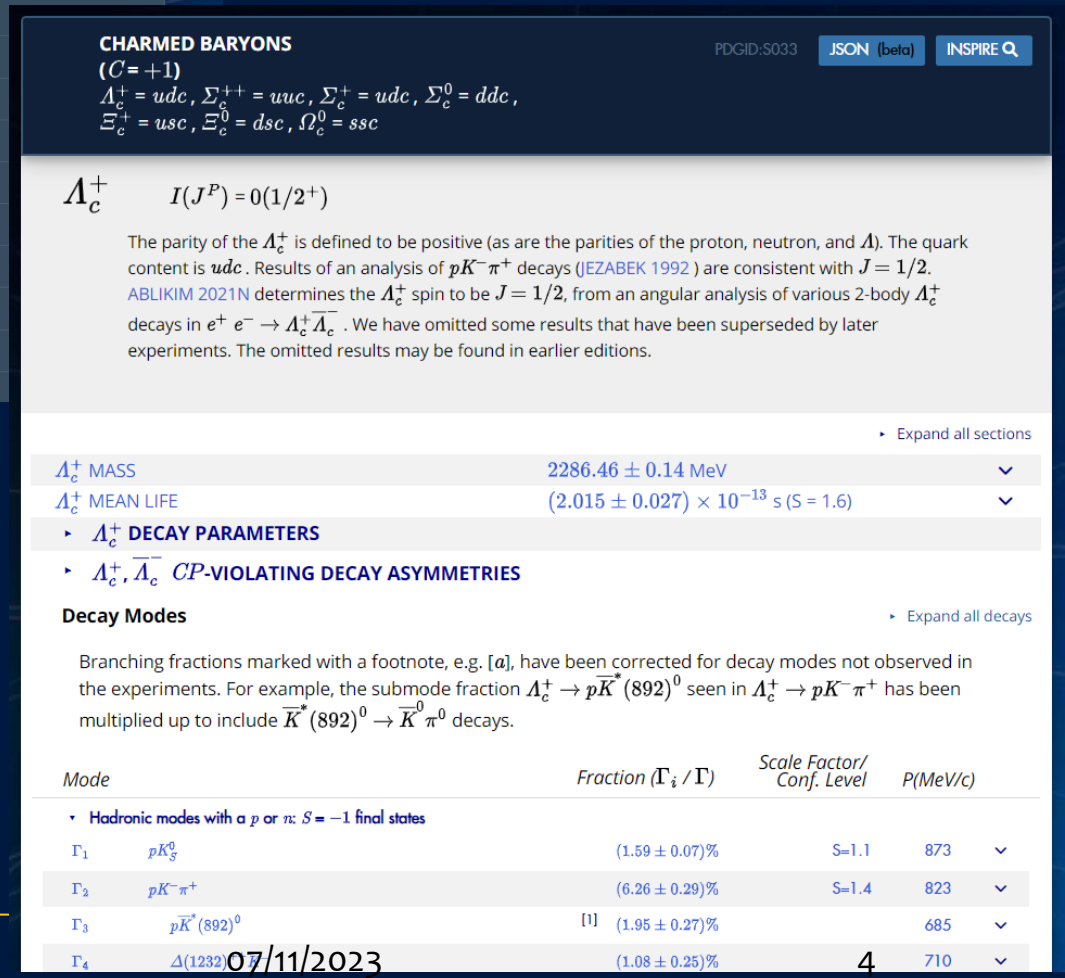
The Review of P
R.L. Workman et al. (Particle Data Group), Prog
Gauge & Higgs Bosons
reviews
γ
gluon
graviton
W
Z
H
Neutral Higgs Bosons, Searches for
Charged Higgs Bosons (H±, H±±)
Heavy Bosons
Axions
Leptons
e
μ
τ
Heavy Charged Lepton
Neutrino Properties
Number of Neutrino Types
Double β-Decay
Neutrino Mixing
Heavy Neutral Leptons
t'
Free quark
Mesons
reviews
Light Unflavored
Strange
Charmed
Charmed, Strange (incl. possibly non-qq̄ states)
Bottom
Bottom, Strange
Bottom, Charmed
cc̄ (incl. possibly non-qq̄ states)
bb̄ (incl. possibly non-qq̄ states)
Other Mesons
Baryons
reviews
N Baryons
Δ Baryons
Λ Baryons
Σ Baryons
Ξ Baryons
Ω Baryons
Charmed Baryons
Doubly-Charmed
Bottom Baryons
Exotic Baryons
Other Searches
reviews
Magnetic Monopole
Supersymmetric Particles
Technicolor
Quark and Lepton Compositeness
Extra Dimensions
WIMPs
Other Particle Searches
Conservation Laws
reviews
Discrete Space-Time Symm.
Number Conservation Laws


CHARMED BARYONS (C = +1)
Λc+ = udc , Σc++ = uuc , Σc+ = udc , Σc0 = ddc ,
Ξc+ = usc , Ξc0 = dsc , Ωc0 = ssc
Λc+ 1/2+ ****
Λc(2595)+ 1/2− ***
Λc(2625)+ 3/2− ***
Λc(2765)+ or Σc(2765) *
Λc(2860)+ 3/2+ ***
Λc(2880)+ 5/2+
Λc(2940)+ 3/2−
Σc(2455) 1/2+
Σc(2520) 3/2+
Σc(2800)
Ξc+ 1/2+
Ξc0 1/2+
Ξc'+ 1/2+
Ξc'0 1/2+


CHARMED BARYONS
(C = +1)
Λc+ = udc , Σc++ = uuc , Σc+ = udc , Σc0 = ddc ,
Ξc+ = usc , Ξc0 = dsc , Ωc0 = ssc
PDGID:S033
JSON (beta)
INSPIRE
Λc+ I(JP) = 0(1/2+)
The parity of the Λc+ is defined to be positive (as are the parities of the proton, neutron, and Λ). The quark content is udc . Results of an analysis of pK−π+ decays (JEZABEK 1992) are consistent with J = 1/2. ABLIKIM 2021N determines the Λc+ spin to be J = 1/2, from an angular analysis of various 2-body Λc+ decays in e+ e− → Λc+ Λc− . We have omitted some results that have been superseded by later experiments. The omitted results may be found in earlier editions.
Expand all sections
Λc+ MASS 2286.46 ± 0.14 MeV
Λc+ MEAN LIFE (2.015 ± 0.027) × 10−13 s (S = 1.6)
Λc+ DECAY PARAMETERS
Λc+, Λc− CP-VIOLATING DECAY ASYMMETRIES
Decay Modes
Expand all decays
Branching fractions marked with a footnote, e.g. [a], have been corrected for decay modes not observed in the experiments. For example, the submode fraction Λc+ → pK*(892)0 seen in Λc+ → pK−π+ has been multiplied up to include K*(892)0 → K0π0 decays.
Mode
Fraction (Γi / Γ)
Scale Factor/ Conf. Level
P(MeV/c)
Hadronic modes with a p or n: S = −1 final states
Γ1 pK0S (1.59 ± 0.07)% S=1.1 873
Γ2 pK−π+ (6.26 ± 0.29)% S=1.4 823
Γ3 pK*(892)0 [1] (1.95 ± 0.27)% 685
Γ4 Δ(1232)0 (1.08 ± 0.25)% 710

Particle Data Group

- PDG started in 1957 by Rosenfeld and Gell-Mann as a journal review
- Evolve as paper cards
- Digitized in 90th

Particle data group database:

- Around 20 years,
- 223 authors from 148 institutions 24 countries

2)	M026P11	$\Gamma(\eta_c(1S) \to K_0^*(2600)\overline{K} + \text{c.c.})/\Gamma_{\text{total}}$
3)	M055R93	$\Gamma(\chi_{c1}(1P) \to K_2^*(1430)^+ K^- + \text{c.c.})/\Gamma_{\text{total}}$
4)	M055R94	$\Gamma(\chi_{c1}(1P) \to K_2^*(1430)\overline{K}^0 + \text{c.c.})/\Gamma_{\text{total}}$
5)	M059R34	$\Gamma(\eta_c(2S) \to K_2^*(1430)\overline{K} + \text{c.c.})/\Gamma_{\text{total}}$
6)	M059R35	$\Gamma(\eta_c(2S) \to K_0^*(1950)\overline{K} + \text{c.c.})/\Gamma_{\text{total}}$
7)	M059R37	$\Gamma(\eta_c(2S) \to a_0(1710)\pi)/\Gamma_{\text{total}}$
8)	M059R38	$\Gamma(\eta_c(2S) \to a_0(1450)\pi)/\Gamma_{\text{total}}$
9)	M059R39	$\Gamma(\eta_c(2S) \to a_2(1700)\pi)/\Gamma_{\text{total}}$
10)	M059R40	$\Gamma(\eta_c(2S) \to K_0^*(2600)\overline{K} + \text{c.c.})/\Gamma_{\text{total}}$

New Generic Nodes

1)	M300A09	$K_0^*(2600)$ $I(J^P) = 1/2(0^+)$

New Measurements

	Node	Document ID	Used?	Value (units)			
1)	M019M	AAIJ 2023AH[1]	N	$1493 \pm 4 \pm 7$ (MeV)			
	1(Linkage=F): From a Dalitz plot analysis of $\eta_c(2S) \to K_S K^+ \pi^- + c.c.$.						
2)	M019W	AAIJ 2023AH[1]	N	$215 \pm 7 \pm 4$ (MeV)			
	1(Linkage=A): From a Dalitz plot analysis of $\eta_c(2S) \to K_S K^+ \pi^- + c.c.$.						
3)	M026M	AAIJ 2023AH	U	$2985.01 \pm 0.17 \pm 0.89$ (MeV)	35k	LHCB	$B^+ \to K^+(K_S^0 K^- \pi^+)$ edit/del
4)	M026P10	AAIJ 2023AH	U	seen		LHCB	$B^+ \to K^+(K_S^0 K^- \pi^+)$ edit/del
5)	M026P11	AAIJ 2023AH	U	seen		LHCB	$B^+ \to K^+(K_S^0 K^- \pi^+)$ edit/del
6)	M026R11	AAIJ 2023AH	U	seen		LHCB	$B^+ \to K^+(K_S^0 K^- \pi^+)$ edit/del
7)	M026R45	AAIJ 2023AH	U	seen		LHCB	$B^+ \to K^+(K_S^0 K^- \pi^+)$ edit/del
8)	M026R46	AAIJ 2023AH	U	seen		LHCB	$B^+ \to K^+(K_S^0 K^- \pi^+)$ edit/del
9)	M026R48	AAIJ 2023AH	U	seen		LHCB	$B^+ \to K^+(K_S^0 K^- \pi^+)$ edit/del

PDG workspace

Edit measurement

Node: M019W
Document ID: AAIJ 2023AH
* Used?: not used
Comment: $B^+\to K^+ (K_S^0 K^- \pi^+)$
preview comment

New footnote:
preview footnote
Link to existing footnote(s)
Save measurement | Close

Show additional fields

Since a few years,
a web interface for

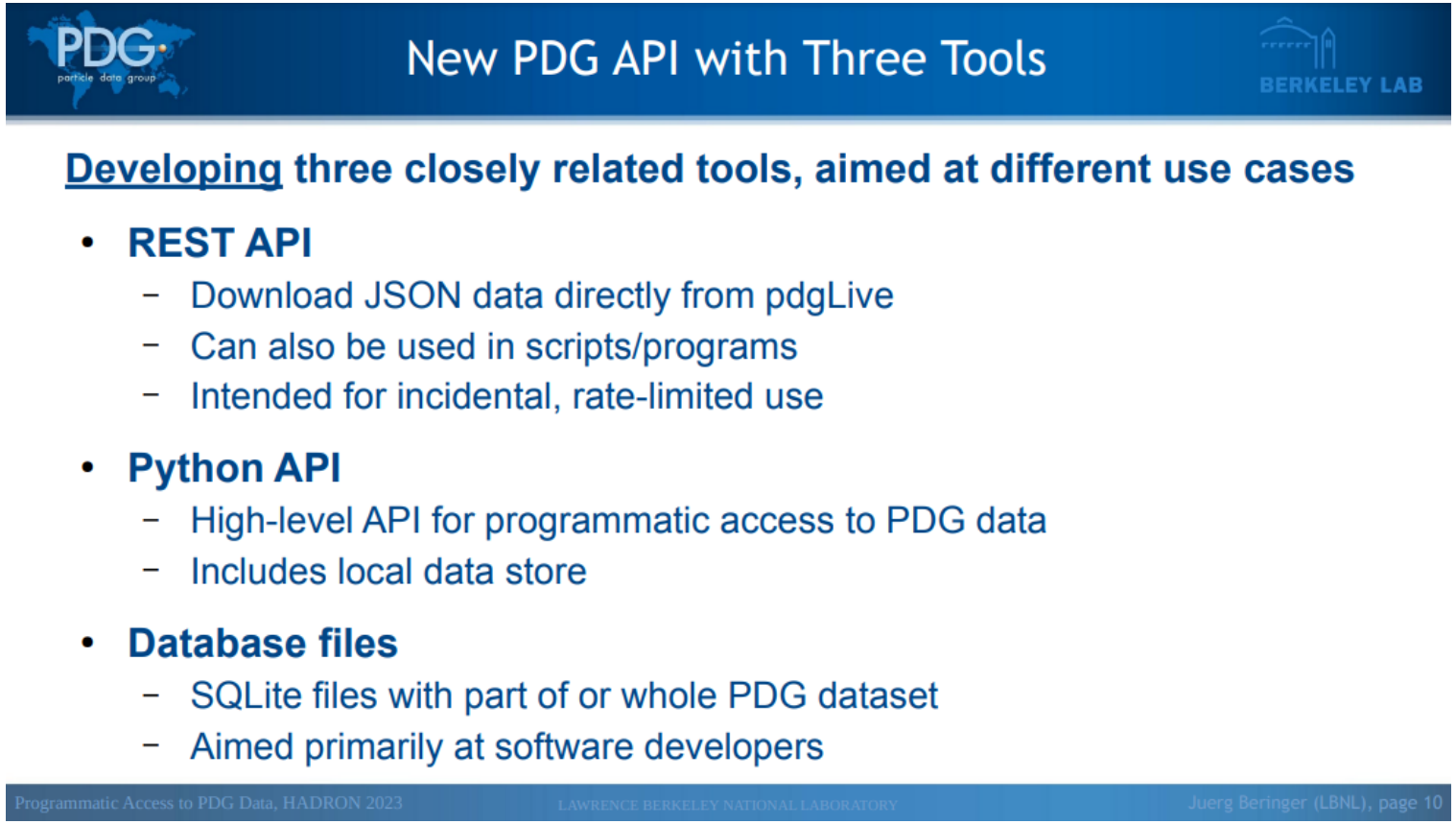
encoding: typing information from published journal papers

and **overseeing:** checking others encodings

~ 10 papers / person / yr

PDG API announcement [webcite]

- **Pushed by a demand of the community (regular surveys)**
- **Driven by FAIR principle**
- **Currently only core PDG data**
  - Particle listings
  - Measurements & Limits
- **Promised more…**



[Talk of Juerg Beringer, HADRON 2023]

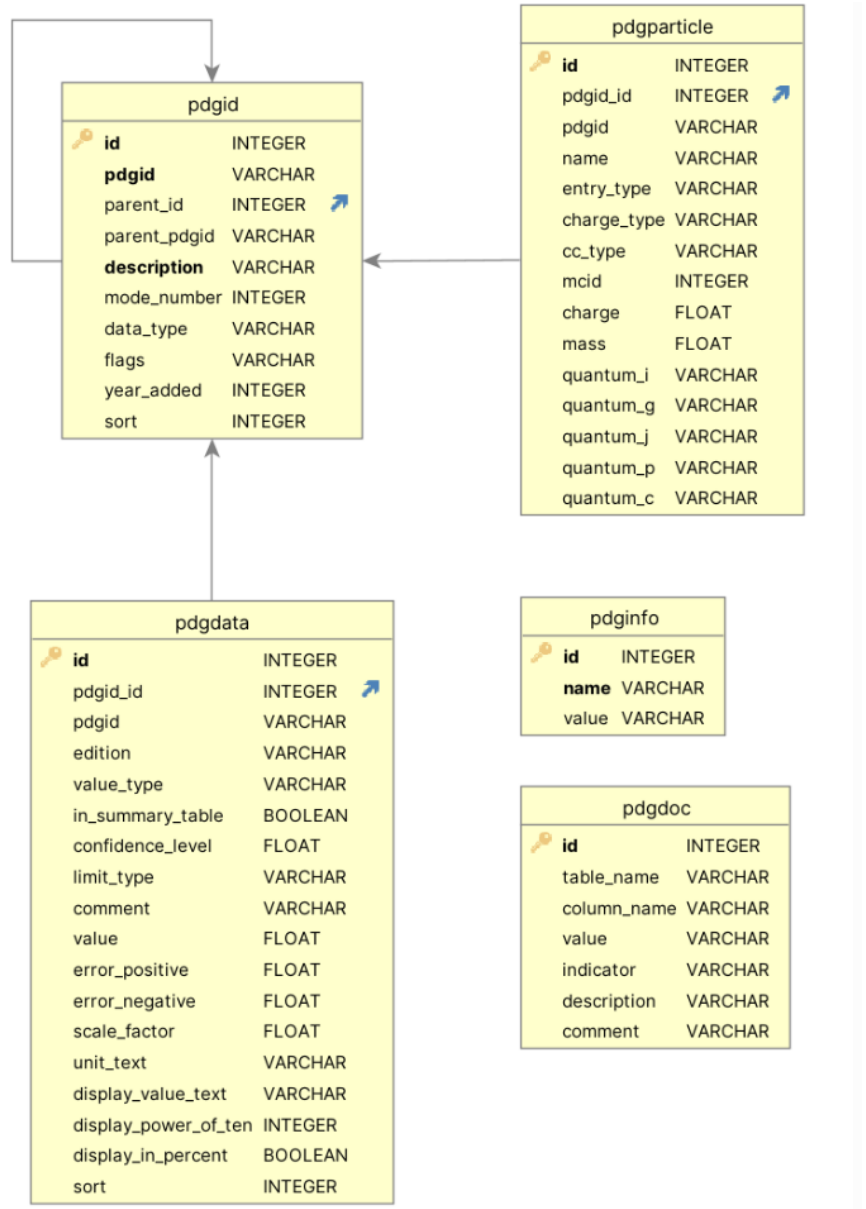
Structure of the DB

	id	name	value
	Int64	String	String
1	73	"producer"	"Particle Data Group (PDG)"
2	74	"status"	"beta version, for testing only"
3	75	"schema_version"	"0.1"
4	76	"data_release"	"1685491481.08578"
5	77	"data_release_timestamp"	"2023-05-30 17:04:41 PDT"
6	78	"edition"	"2023"
7	79	"citation"	"R.L. Workman et al. (Particle Data Gr
8	80	"license"	"CC BY-NC 4.0"
9	81	"about"	"For further information see https://p

```
begin
    const db_path = joinpath(@__DIR__, "pdg-2023-v0.0.5.sqlite")
    if !(isfile(db_path))
        db_url = "https://pdg.lbl.gov/2023/api/pdg-2023-v0.0.5.sqlite"
        download(db_url, db_path)
    end
    PDGdb.connect(db_path)
end
```

5×3 DataFrame

Row	name	num_rows	num_cols
	String	Int64	Int64
1	pdgdoc	62	7
2	pdginfo	9	3
3	pdgid	19404	10
4	pdgparticle	1233	15
5	pdgdata	17655	18

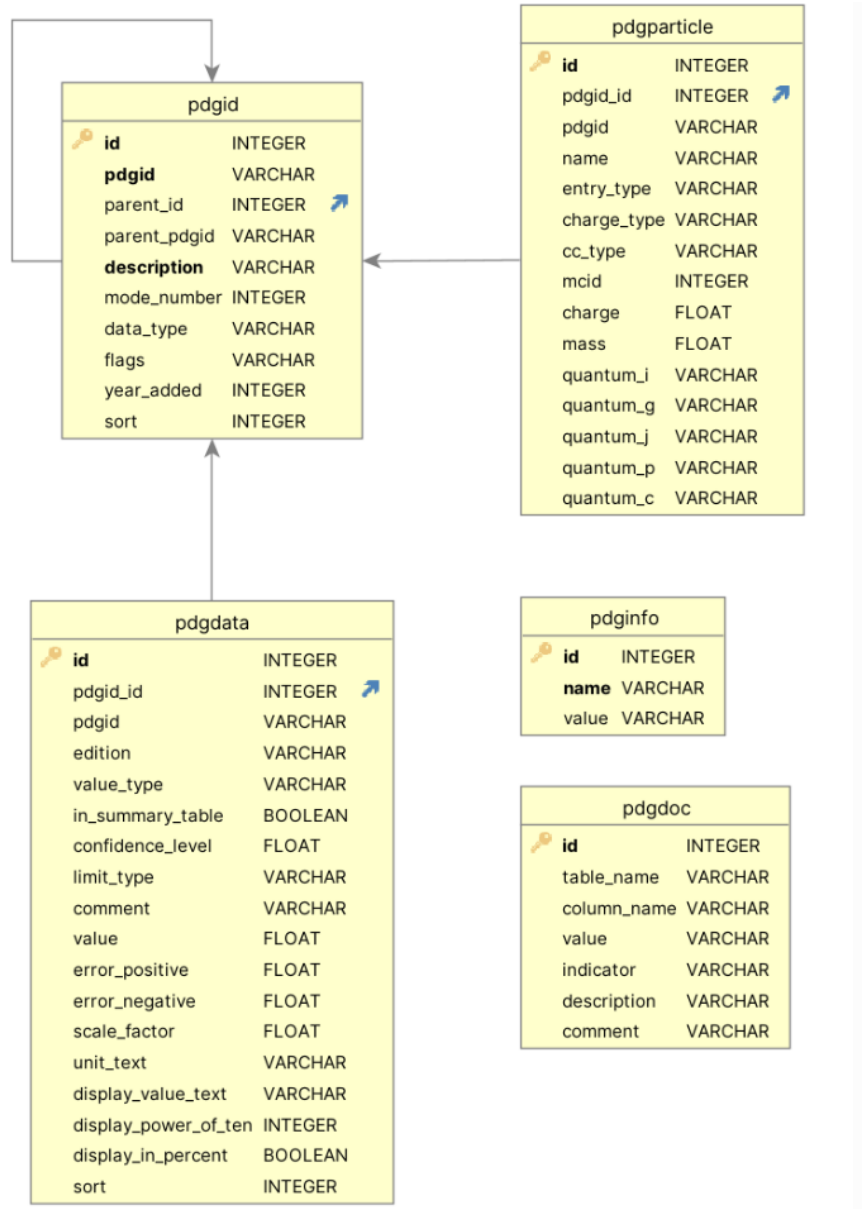


Access particle properties

1. Read SQL database convert to DataFrame
2. Search for the name in pdgparticle
3. Read the pdgid
4. Select info in pdgdata by pdgid
5. Leftjoin with pdgid by id
6. Access mass, width, pole parameters
7. Read decay channels, branching fraction

Looks simple?

PDGdb.pdfparticle, PDGdb.pdfid, PDGdb.pdfdata



Issues and physics

Generic notes vs charge-specific notes:

- u and d quarks have ~ same mass

=> Isospin symmetry leads to multiplets

- $[u\bar{d},\ u\bar{u}, d\bar{d}, d\bar{u}]$ might all correspond to generic $\rho(770)$
- $[b\bar{u}, b\bar{d}]$ to generic B-meson
- [bsu, bsd] would be generic Ξ_b

But for some, there are charge specific

+ Many typos / missing / repeated information

Current API for exploration

pdg(“guessname”)

Suggestions for the names of the particles

Using token-based distance between registered names

properties(“pdgid”)

pdg(“guessname”) |> properties

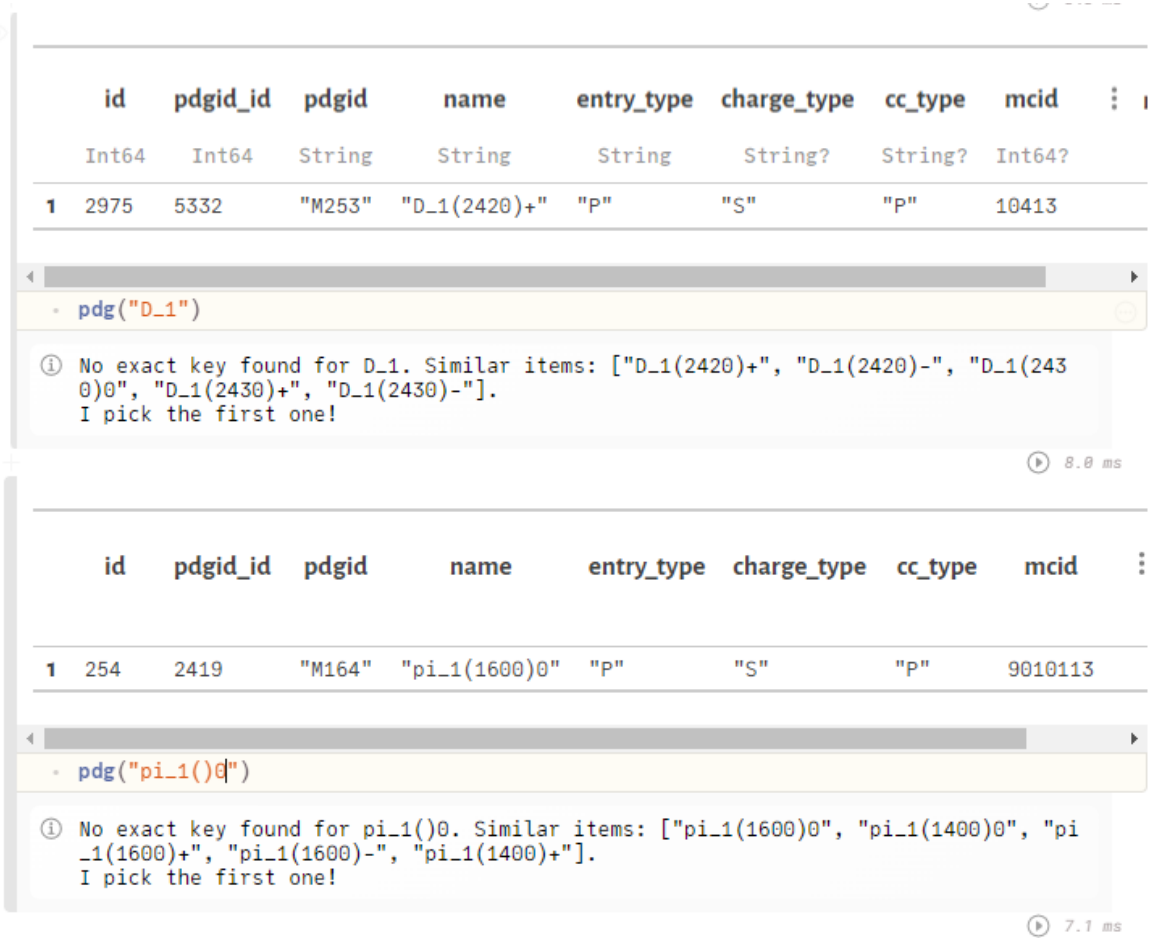
get data + description

properties(“pdgid”) |> parameters

mass, width, pole position

properties(“pdgid”) |> decays

decay channels



	id	pdgid_id	pdgid	name	entry_type	charge_type	cc_type	mcid
	Int64	Int64	String	String	String	String?	String?	Int64?
1	2975	5332	"M253"	"D_1(2420)+"	"P"	"S"	"P"	10413

```
pdg("D_1")
```

```
No exact key found for D_1. Similar items: ["D_1(2420)+", "D_1(2420)-", "D_1(2430)0", "D_1(2430)+", "D_1(2430)-"].
I pick the first one!
```

8.0 ms

	id	pdgid_id	pdgid	name	entry_type	charge_type	cc_type	mcid
1	254	2419	"M164"	"pi_1(1600)0"	"P"	"S"	"P"	9010113

```
pdg("pi_1()0")
```

```
No exact key found for pi_1()0. Similar items: ["pi_1(1600)0", "pi_1(1400)0", "pi_1(1600)+", "pi_1(1600)-", "pi_1(1400)+"].
I pick the first one!
```

7.1 ms

Summary

The PDG is on the track to make the databases available. **Decays properties are accessible!**

MySQL is the internal format; new releases will be in the same form.

We get to deal with the historic records.

not-clean: physics-aware **processing** and **cleaning** is needed.

not-consistent: feedback to the PDG is appreciated. Collected in [Issues]

Cleaned and shaped DB can be exported e.g. to Corpuscles.jl, scikit-hep/particle